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Effects of Second Language Learning on Mental Representations of Time

Erratum

2017-04-01

Effects of Second Language Learning on Mental Representations of Time

By Conner S. Clark

Edited by Dr. Allen Clark

Abstract

The following paper is a domain-centered study that looks at the effects of second language (L2) learning on mental representations of time in advanced L2 learners of Mandarin Chinese, and compares them to their English native speaking (non-learners of Mandarin Chinese) counterparts. The design of this study attempts to observe the effects of the existence and use of spatiotemporal metaphors in Mandarin Chinese on L2 learners of the language. The methodology used for data collection includes a three-dimensional pointing paradigm—a partially language-independent task—which attempts to isolate cognitive behavior. The task requires participants to answer questions (by pointing) regarding space and time on imaginary axes in front of their person using their own fist as the reference point in their answer; this precludes any language effects caused by having to use language in completing experimental tasks. The participants of the study include advanced L2 learners of Mandarin Chinese as the focus experimental group and English native speakers as the control group. Results confirm the hypothesis that learning a second language does influence speakers' mental representations of time; while English native speakers significantly preferred the transverse axis in virtually all cases, L2 Mandarin learners displayed a preference for both the transverse and sagittal axes, without significantly distinguishing between the two. This study adds to previous literature in the field, providing evidence in support of the Linguistic Relativity Theory.

I. Introduction

For hundreds of years, academics of all cultures have recognized that speaking different languages may influence a person's perception of the world around them. An old Chinese proverb says, "To learn a language is to have one more window from which to look at the world." Still, one of the most famous—and somewhat comical—sayings regarding language is attributed to Emperor Charles V, "I speak Spanish to God, Italian to women, French to men and German to my horse." While there is no real logical reasoning behind

any of these specific categorical usages of language, some academics would say he might be on to something. Students of international studies, business, relations, etc. are almost always instructed by their mentors or required by their academic programs to study one, if not two or three foreign languages. Why? Because the best way to truly understand and relate to another culture is by learning and communicating in that culture's native tongue. Apart from the obvious reason of ease of communication, is this possibly because being able to speak

that culture's language makes a person more likely to think as people of that culture do?

This paper aims to add to the existing literature on the subject of linguistic relativity and crosslinguistic influence, more specifically, second language learning and its effects on conceptual perceptions, i.e., mental representations of time. As previous research suggests, there are many cultural and linguistic patterns and factors that could contribute to these differences in conceptual perception (e.g., Athanasopoulos, et. al, 2015; Jarvis, 2008; Whorf & Carroll, 1998; Fuhrman, et. al, 2011; Lai & Boroditsky, 2013). Writing system, writing direction, calendar use, even modern technology such as smartphones could have the power to influence these conceptual perceptions over time. How we talk about and reference time within the boundaries of language is also an extremely important factor that influences cognitive restructuring, as this study shows.

This paper describes the methodology used to design and conduct this specific study and lays out the procedure of the experiment used with each participant. Chapter 3 reports the results of the experiment using statistical analysis results from IBM's Statistical Package for the Social Sciences (SPSS) software. Chapter 4 attempts to explain and expound upon the findings from the Results chapter, referring to previous literature to link

and compare findings from this study with previous studies in hopes of offering original conclusions. This paper concludes by summarizing the study, discussing limitations, and offering suggestions for future studies in the field.

II. Methodology

Research Questions

The overarching question that this study posits and attempts to answer is the following: How do the spatiotemporal metaphors in Mandarin Chinese influence immediate and habitual mental representations of time in English L2 Mandarin learners? More specific to the experiment and methodology discussed in detail in Section 2.3, my research questions are as follows: 1) How do front-back space-time metaphor primers influence the

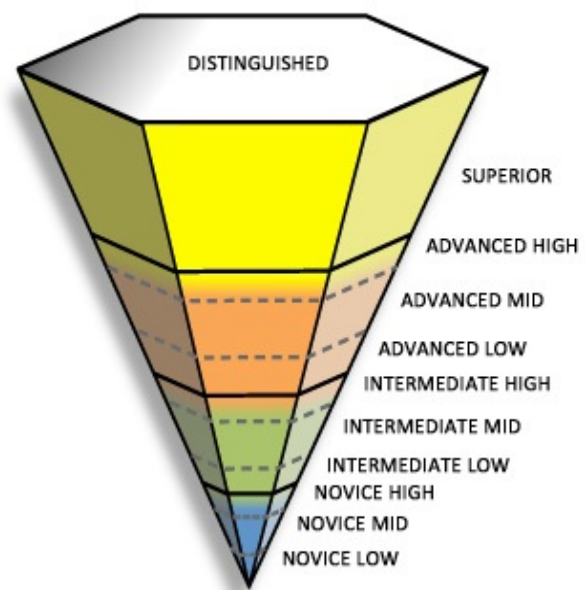


Figure 1 The ACTFL inverted pyramid of test scores (ACTFL)

way L2 Mandarin learners answer temporal questions on an imaginary axis? 2) How do up-down space-time metaphor primers influence the way L2 Mandarin learners answer temporal questions on an imaginary axis? 3) Without space-time metaphor primers, do L2 Mandarin learners still display crosslinguistic influence, i.e., exhibit tendencies in contrast with their English NS counterparts?

Participants

Altogether, 30 people participated in this experiment, and all were tested at the University of Mississippi. Fifteen of the total participants were (American) English natives and tested using English. The other 15 were English NS (L2 Mandarin group) who were students either in a Chinese major (regular track) or in the Chinese Language Flagship Program (advanced track) at the University. All the L2 Mandarin students were at the advanced level (400 or 500 course level) at the time of testing and were tested using Mandarin Chinese. On the background questionnaire, the L2 Mandarin participants were asked to report their latest scores on the Oral Proficiency Interview (OPI)³⁸ and the

³⁸ "The ACTFL Oral Proficiency Interview (OPI) is a valid and reliable means of assessing how well a person speaks a language. It is a 20-30 minute one-on-one interview between a certified ACTFL tester and examinee. The interview is interactive and continuously adapts to the interests and abilities of the speaker. The speaker's performance is compared to the criteria outlined in the ACTFL Proficiency Guidelines 2012 - Speaking or the Inter-Agency Language Roundtable Language Skill Level Descriptors – Speaking. The interview is double rated

American Council on the Teaching of Foreign Languages (ACTFL) Listening³⁹ and Reading⁴⁰ Proficiency Assessments, which range from 'novice-low' to 'distinguished' as seen in the figure above. Each level is not only measured by skill of language use; it also has a corresponding level of cultural awareness, sensitivity, knowledge, etc.

The participants' ages ranged from 18 years to 29 years, with an average age of 21.2. The L2 Mandarin group's average number of years spent studying

and an Official ACTFL Oral Proficiency Certificate stating the candidate's proficiency level is issued to the candidate" (ACTFL).

³⁹ "The Listening Proficiency Test (LPT) is a standardized, computer-delivered test for the global assessment of listening ability in a language. LPTs measure how well a person understands spoken discourse as described in the ACTFL or ILR rating scales. The listening passages and multiple choice questions and answers are presented in the target language. Designed by testing experts, LPTs are carefully constructed assessments which evaluate Novice to Superior levels of listening ability. Most commonly, the test is administered to assess a specific range of proficiency from Novice Low to Intermediate Mid; Intermediate Mid to Advanced Mid, and Advanced Low to Superior" (ACTFL).

⁴⁰ "The Reading Proficiency Test (RPT) is a standardized, computer-delivered test for the global assessment of reading ability in a language. RPTs measure how well a person understands spoken discourse as described in the ACTFL or ILR rating scales. The reading texts and multiple choice questions and answers are presented in the target language. Designed by testing experts, RPTs are carefully constructed assessments which evaluate Novice to Superior levels of reading ability. Most commonly, the test is administered to assess a specific range of proficiency from Novice Low to Intermediate Mid; Intermediate Mid to Advanced Mid, and Advanced Low to Superior. Multiple language tests are available" (ACTFL).

Mandarin was 4.2 years. 60% of the L2 Mandarin learners had lived in a Chinese-speaking country in the past; the average number of months lived in the country was 7.61. 80% of the L2 Mandarin participants achieved an Advanced level on their OPI; 20% received an Intermediate level. 33.33% of the L2 Mandarin participants achieved an Intermediate High, 33.33% achieved an Advanced Low, and 33.33% achieved an Advanced Mid on their ACTFL LPT. As for the RPT, 6.67% achieved an Intermediate High, 46.67% achieved an Advanced Low, 40% achieved an Advanced Mid, and 6.67% achieved an Advanced High.

Instrument

I used the three-dimensional pointing paradigm used in Fuhrman, et al. (2011) and Lai and Boroditsky (2013) with a minor adjustment: I asked the participant to place their own hand about a foot in front of their chest in a closed fist.⁴¹ I then proceeded to ask the participant one of the test questions in Appendix C (samples below).

⁴¹ In Fuhrman, et al. (2011) and Lai and Boroditsky (2013), one of the experimenters put their own hand a foot in front of the participant. Their hand was in the Italian “che vuoi” gesture, with the palm up and thumb and fingers touching together, forming a sort of cone. For ease of instructions, I had the participants simply form a fist with their hand. Because this was a research project done by myself, I had the participants put their own fist in front of their chest so that I was free to take notes and record results.

Table 1 Sample Non-spatial Language Question: Assume this is today. Where is tomorrow? Where is yesterday?

假設	這	是	今天。
assume	this	is	today
明天	在	哪裡？	昨天
tomorrow	located	where	yesterday
在	哪裡？		
located	where		

Table 2 Sample Space-Time Metaphor (Front-back) Question: Assume this is today. Where is the day after tomorrow? Where is the day before yesterday?

假設	這	是	今天。
assume	this	is	today
後天	在	哪裡？	前天
back-day	located	where	front-day
在	哪裡？		
located	where		

Table 3 Sample Space-Time Metaphor (Up-Down) Question: Assume this is Wednesday. Where is next Wednesday? Where is last Wednesday?

假設	這	是	星期三。
assume	this	is	Wednesday
下	個	星期三	在
down	CL-ge	Wednesday	located
哪裡？	上	個	星期三
where	up	CL-ge	Wednesday
在	哪裡？		
located	where		

Table 4 Sample Distractor Question: Assume this is the school. Where is the house? Where is the movie theater?

假設	這	是	學校。
assume	this	is	school
房子	在	哪裡？	電影院
house	located	where	movie theater
在	哪裡？		
located	where		

There were 24 questions in total: six non-spatial (NS), four front-back metaphor (FB), four up-down metaphor (UD), and ten distractor questions (DQ). The non-spatial language questions were designed to test how participants answered without spatiotemporal metaphors as immediate primers. These types of questions aimed to evaluate the long-term or lasting effects languages have on the mental representations of space-time. The second and third groups of questions, i.e., the front-back and up-down metaphor questions, were designed to evaluate the immediate effects using language has on the conceptualization of space and time. The first 12 questions were asked in the following pattern: NS – FB – DQ, NS – UD – DQ, NS – FB – DQ, NS – UD – DQ. I designed this pattern to observe whether there would be differences in the participants' answers to non-spatial and metaphor questions side-by-side without separation by distractor questions. After each set of two, however, I still placed a distractor question to prevent participants from figuring out a pattern. The latter 12 questions of the test were mixed together and dispersed among the distractor questions.

Due to the prevalence of up-down and front-back temporal metaphors in Mandarin Chinese, advanced learners of the language should show effects of crosslinguistic influence in their mental representations of time both from

habitual use and direct context of the situation (i.e., if spatial metaphors are used). I hypothesized that when L2 Mandarin speakers are tested in Mandarin and prompted with spatial metaphors, i.e., when asked questions in groups two and three, their representations of time would be more similar to Mandarin NS, in large part due to the lexicon of the language, meaning that when primed with front-back space-time metaphors, the L2 Mandarin group would show significant preference for the sagittal axis and when primed with up-down space-time metaphors, they would display a preference for the vertical axis. However, when L2 Mandarin speakers are tested in Mandarin using non-spatial primers (group one questions), I hypothesized they would still display crosslinguistic influence in their mental representations of time, albeit in a weaker fashion, simply because they are using and thinking in Mandarin, meaning that they should show some preference for axes other than the expected preferred axis for English NS, i.e., the transverse axis.

Hypotheses

For ease of reference, I will restate my research questions here: 1) How do front-back space-time metaphor primers influence the way L2 Mandarin learners answer temporal questions on an imaginary axis? 2) How do up-down space-time metaphor primers influence the way L2 Mandarin learners answer

temporal questions on an imaginary axis? 3) Without space-time metaphor primers, do L2 Mandarin learners still display crosslinguistic influence, i.e., exhibit tendencies in contrast with their English NS counterparts?

Due to the prevalence of up-down and front-back temporal metaphors in Mandarin Chinese, advanced learners of the language should show effects of crosslinguistic influence in their mental representations of time both from habitual use and direct context of the situation (i.e., if spatial metaphors are used). I hypothesized that when L2 Mandarin speakers are tested in Mandarin and prompted with spatial metaphors, i.e., when asked questions in groups two and three (see Section 2.3), their representations of time will be more similar to Mandarin NS results in previous studies, in large part due to the lexicon of the language, meaning that when primed with front-back space-time metaphors, the L2 Mandarin group would show significant preference for the sagittal axis and when primed with up-down space-time metaphors, they would display a preference for the vertical axis. When L2 Mandarin speakers are tested in Mandarin using non-spatial primers (group one questions), however, I hypothesized they will still display crosslinguistic influence in their mental representations of time, albeit in a weaker fashion, simply because they are using and thinking in Mandarin, meaning that they should show some

preference for axes other than the expected preferred axis for English NS, i.e., the transverse axis.

Procedure

All participants were first contacted via email with the link to the consent to participate and background questionnaire form using Qualtrics for them to answer. Once the participant completed this first portion, if they were an L2 Mandarin speaker, the form then directed them to a link to complete the Mandarin grammar quiz to ensure near-native comprehension of the words and phrases that were used in the experiment. Last, the participants signed up to meet with me on a day and time of their choosing on a Google Sheets spreadsheet. Once each participant signed up, I proceeded to contact them and determine a meeting place, either in an office, empty classroom, or study area in the campus library. When I met with each participant, I explained to them the instructions and how the experiment would work. After this, I went through two practice questions with the participant to ensure they understood was expected of them, and asked if the participant had any questions before we started.

I asked the participant to put out their non-dominant hand about 12 inches or 30 centimeters in front of their chest in a closed fist. I explained to them that that would be the reference point around which they would frame

their answers to the questions I ask. I then proceeded to ask a series of questions to which the participant answered using their fist as the reference point. They used their other (dominant) hand to point to any space around their fist, any direction around and any distance away from their fist being acceptable. I paused after asking each question to give the participant time to answer/point and to give me time to record their answer. After I finished asking all the test questions, I then thanked the participant for their participation in this study.

Ethical Considerations

Due to the nature of the study in dealing with the observation of human subjects, before beginning the experiment, I asked each participant to read and digitally initial a consent form that was designed by me and reviewed/approved beforehand by the University of Mississippi's Institutional Review Board (IRB). My application to conduct research with human participants, "Crosslinguistic Influence on Mental Representations of Time in English-Mandarin Bilinguals" (Protocol #17x-055), was approved as Exempt under UM Policy RSP.301.015 (Category #7).

Data Analysis

When conducting the experiment, I recorded the participants' answers "L" for left, "R" for right, "U" for up, "D" for down, "F" for front, and "B" for back depending on where they pointed

in relation to their fist. To convert these answers into numerical data for input, I simply recorded the frequency each participant answered on a specific axis (left/right = transverse, up/down = vertical, front/back = sagittal) for each type of question (non-spatial, up/down, front/back), i.e., what type of words with which each question prompted them. As you will see in the following chapter, I then used SPSS to conduct a two-way mixed ANOVA to observe the interaction effect of language and axis preferences, followed by a one-way repeated measures ANOVA conducted with each language group separately to see how each language influenced axis preference.

III. Results

As mentioned previously, I hypothesized that when primed with either front-back or up-down metaphors, the L2 Mandarin group would display a conception of space-time contrary to the English NS group and instead resemble Mandarin NS because of their (long-term) exposure to and study of the Mandarin Chinese language. This chapter reports the priming effects of space-time metaphors as well as a more general second-language effect between the three axes (transverse, vertical, and sagittal), and compares the interaction effect between the different language groups and their axis preference. A two-way mixed ANOVA test was conducted

using SPSS to observe the interaction effect between language and axis preference. A one-way repeated measures ANOVA was then conducted to see how language influenced axis preference for each language group.

Front-Back Metaphor Priming

The front-back metaphor priming questions (four total) were designed to test the immediate effects of space-time metaphors on the participants' mental representations of time. I hypothesized that when L2 Mandarin speakers are tested in Mandarin and prompted with these spatial metaphors, their representations of time would display crosslinguistic influence, causing them to associate these space-time priming words with specific axes, i.e., when primed with front-back metaphors, L2 Mandarin speakers would show a relatively significant preference for the sagittal axis when answering the test questions.

Table 5 Front-back metaphor priming: Mean scores for axis preference; F^{42} , p^{43} , and $\eta^2_{p^{44}}$ values from a one-way repeated measures ANOVA.

	Transverse		Vertical		Sagittal		F	p	$\eta^2_{partial}$
	M	SD	M	SD	M	SD			
English NS (n=15)	3.53	1.06	.00	.000	.33	1.05	(1.02, 14.27)	.000	.789
							= 52.43		
L2 Mandarin (n=15)	2.13	1.81	.07	.258	1.80	1.78	(1.03, 14.43)	.031	.289
							= 5.68		

There was a significant Axis x Language interaction effect, $F(1.03, 28.78) = 7.10$, $p = .012$, $\eta^2_{partial} = .202$, which means that axis preference did significantly differ based on language group. This also supports my original hypothesis that language can influence mental representations of time.

⁴² The *F*-statistic or *F*-ratio compares the amount of systematic vs unsystematic variance in the data tested, i.e., the ratio of the model to its error (Field, 2009).

⁴³ The *p* value tells us if the experimental effect is significant. If $p < .05$, the effect is significant (Field, 2009).

⁴⁴ *Partial eta squared* measures the effect size in ANOVA. It differs from *eta squared* in that it looks at the proportion of variance (not explained by the other variables in the analysis) that the variable explains (Field, 2009). Suggested norms for partial eta-squared: small = 0.02; medium = 0.13; large = 0.26 (Cohen, 1988). Effect size is imperative to calculate because it indicates how meaningful the observed effect is: just because a test statistic is significant does not indicate that the effect it measures is important (Field, 2009).

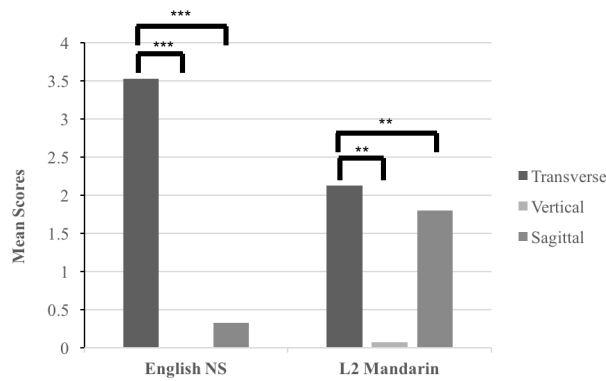


Figure 2 Front-back metaphor priming: Mean scores for axis preference for English NS and L2 Mandarin speakers. * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$

English NS one-way repeated measures ANOVA results show a significant effect for axis preference, $F(1.02, 14.27) = 52.43$, $p = .000$, $\eta^2_{\text{partial}} = .789$. Bonferroni corrected post hoc tests indicate that, once again, the English NS group significantly preferred the transverse axis in all cases ($p = .000$) with no significant preference difference between the vertical and sagittal axes ($p = .713$). L2 Mandarin group results also show a significant effect for axis preference, $F(1.03, 14.43) = 5.68$, $p = .031$, $\eta^2_{\text{partial}} = .289$. The Bonferroni corrected post hoc tests show that there was a significant difference in preference between the transverse and vertical axes ($p = .002$) and the vertical and sagittal axes ($p = .002$), with the L2 Mandarin group preferring the transverse axis in the former case and the sagittal axis in the latter. There was not a significant difference in preference, however, between the transverse and sagittal axes ($p = 1.000$), meaning that a L2 Mandarin speaker was just as likely to prefer thinking of

time on the transverse axis as the sagittal axis when primed with front-back space-time metaphors, thus confirming my hypothesis.

Up-down Metaphor Priming

Just like the front-back metaphor priming questions, the up-down metaphor priming questions (four total) were designed to test the immediate effects of space-time metaphors on the participants' mental representations of time. I hypothesized that when L2 Mandarin speakers are tested in Mandarin and prompted with these spatial metaphors, their representations of time would display crosslinguistic influence, causing them to associate these space-time priming words with specific axes, i.e., when primed with up-down metaphors, L2 Mandarin speakers should show a significant preference for the vertical axis when answering the test questions.

Table 6 Up-down metaphor priming: Mean scores for axis preference; F , p , and η^2_p values from a one-way repeated measures ANOVA.

	Transverse		Vertical		Sagittal		F	p	η^2_{partial}
	M	SD	M	SD	M	SD			
English NS (n=15)	3.33	1.05	.07	.258	.40	1.06	(1.11, 15.52)	.000	.757
							= 43.68		
L2 Mandarin (n=15)	2.13	1.60	.40	.74	1.47	1.51	(1.34, 18.75)	.043	.234
							= 4.28		

Similar to the previous tests, there was a significant Axis x Language interaction effect, $F(1.27, 35.58) = 5.29$, $p = .020$, $\eta^2_{\text{partial}} = .159$. Axis preference did significantly differ between

language groups when primed with up-down spatiotemporal metaphors, confirming my original hypothesis.

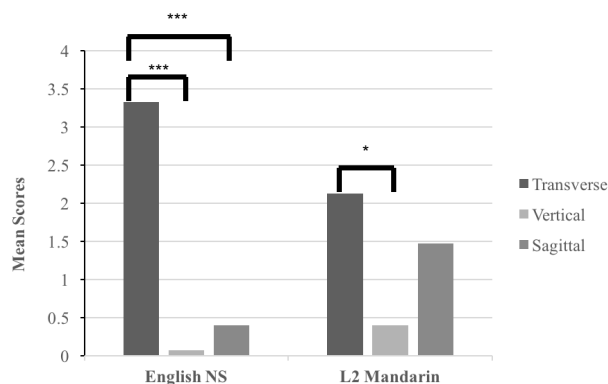


Figure 3 Up-down metaphor priming: Mean scores for axis preference for English NS and L2 Mandarin speakers. * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$.

A one-way repeated measures ANOVA for the English NS group indicated that there was, once again, a significant effect of axis preference, $F(1.11, 15.52) = 43.68$, $p = .000$, $\eta^2_{\text{partial}} = .757$. Bonferroni post hoc tests confirmed that, in all cases like the previous tests, English NS speakers prefer the transverse axis to both the vertical and sagittal axes ($p = .000$), with no preference difference between the latter two axes themselves. For the L2 Mandarin speakers, the results also showed a significant effect of axis preference when primed with up-down space-time metaphors, $F(1.34, 18.75) = 4.28$, $p = .043$, $\eta^2_{\text{partial}} = .234$. The Bonferroni corrected post hoc tests revealed that the L2 Mandarin group significantly preferred the transverse to the vertical axis ($p = .013$), but had no preference difference when comparing the transverse and sagittal axes ($p = 1.00$) or the sagittal and vertical axes (p

$= .100$), which means that when primed with up-down metaphors, to a certain extent, L2 Mandarin speakers still preferred thinking of time on either the transverse or sagittal axes rather than the vertical one. This is quite interesting because the results indicate there is still crosslinguistic influence, but not in accordance with my hypothesis which suggests that there would be a preference for the vertical axis if primed with up-down space-time metaphors. The L2 Mandarin group instead continued to show greater preference for the sagittal axis (along with the transverse axis), which received a mean score of 1.47 while the vertical axis had a mean score of .40. I will discuss the implications of this further in the Discussion.

Non-spatial Priming

The non-spatial priming questions (six total) were designed to test the lasting or habitual effects of studying Mandarin Chinese long-term on mental representations of time. Due to the prevalence of space-time metaphors in the Mandarin Chinese language, while using Mandarin and thinking within this lexical framework to answer these questions, I hypothesized that L2 Mandarin speakers would still display crosslinguistic influence in their mental representations of time when tested using non-spatial primers, albeit in a weaker fashion, e.g., show a slight tendency to choose something other

than the hypothesized English NS preferred transverse axis.

Table 7 Non-spatial priming: Mean scores for axis preference; F , p , and η^2_p values from a one-way repeated measures ANOVA.

	Transverse		Vertical		Sagittal		F	p	$\eta^2_{partial}$
	M	SD	M	SD	M	SD			
English NS (n=15)	5.60	1.55	.00	.000	.40	1.55	(1, 14) = 61	.000	.813
L2 Mandarin (n=15)	3.47	2.36	.53	1.36	2.00	2.27	(2, 28) = 5.15	.012	.269

Results from the two-way mixed ANOVA also indicate that there was a significant Axis x Language interaction, $F(1.36, 38.18) = 6.4$, $p = .009$, $\eta^2_{partial} = .186$. This signifies the preferences of the three axes significantly differed between the L2 Mandarin and English NS groups, supporting my original hypothesis. The partial eta-squared value is larger than 0.13 which indicates that there was a medium effect size.

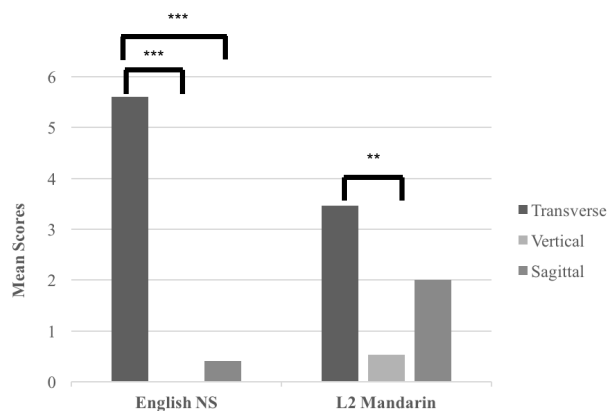


Figure 4 Non-spatial priming: Mean scores for axis preference for English NS and L2 Mandarin speakers. * $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$.

Looking at the results from the one-way repeated measures ANOVA for the English NS group, we see that there was a significant effect of axis

preference, $F(1, 14) = 61$, $p = .000$, $\eta^2_{partial} = .813$. Bonferroni post hoc tests indicate that there was a significant preference of the transverse axis over both the vertical and sagittal axis ($p = .000$), and no difference in preference between the vertical and sagittal axes ($p = 1.00$). For the L2 Mandarin group, we also see a significant effect of axis preference, $F(2, 28) = 5.15$, $p = .012$, $\eta^2_{partial} = .269$. The Bonferroni adjusted post hoc tests show that L2 Mandarin speakers significantly preferred the transverse axis over the vertical axis ($p = .008$), but did not have a significant preference between the transverse and sagittal axes ($p = .659$) or the vertical and sagittal axes ($p = .211$). The effect size for both tests were greater than the "large" threshold for partial eta squared.

IV. Discussion

From the results in the previous chapter, my hypotheses were confirmed to some degree, but at the same time there were also interesting findings that I will further discuss in this chapter. Along with a general discussion of the results, this chapter considers the implications of said results and touch on some of the more interesting findings that I discovered while carrying out the experiment with the participants.

Front-back Space-Time Metaphor Priming

My hypothesis for front-back spatiotemporal metaphor priming was

that when L2 Mandarin speakers were prompted with these types of metaphors, they would show a relatively significant preference for the sagittal axis when answering the questions. Results do show this to be the case. As shown in Figure 2, the L2 Mandarin group significantly preferred the transverse ($M = 2.13$) and sagittal ($M = 1.80$) axes to the vertical axis ($M = .07$). There was no significant difference in preference between the sagittal and transverse axes, meaning that L2 Mandarin speakers were almost just as likely to choose the transverse axis (53.25%) as they were the sagittal axis (45%) (while choosing the vertical axis merely 1.75% of the time). This indicates there was a significant immediate effect of front-back spatiotemporal metaphor priming on the mental representations of time in the L2 Mandarin group.

Comparing these L2 Mandarin results to the Mandarin NS group⁴⁵ in

⁴⁵ In Lai and Boroditsky (2013), the participants are described as Mandarin-English bilinguals, however it does not explicitly state whether the participants are L1 Mandarin/L2 English speakers or otherwise. 66 were tested in California with a mean Mandarin proficiency of 4.48 and a mean English proficiency of 4.01 on a self-reported scale from 1 to 5, and 32 were tested in Taiwan with a mean Mandarin proficiency of 5 and mean English proficiency of 2.71. From these proficiency ratings, we can

Lai and Boroditsky (2013) where they chose the transverse axis 57% of the time, the front-back axis 24% of the time, and the vertical axis 19% of the time when prompted with front-back space-time metaphors, we can see some similarities between the two Mandarin-speaking groups, which suggests that L2 learners of Mandarin do indeed begin to think more like native/near-native Mandarin speakers. The transverse axis was still the most preferred axis, and as previous literature suggests, this could be due to many factors, including writing direction. While this might cause a greater difference when looking at results from older Chinese generations (which my study did not include) as the Chinese language used to be read up to down and right to left, in modern day Chinese speaking societies, to include foreign learners of the language, reading left to right is now the norm, thus causing this similarity between English NS, L2 Mandarin, and Mandarin NS in preference for the transverse axis even

assume that all the participants tested in Taiwan were Mandarin NS, and of the participants tested in California, it is safe to say that the vast majority tested were either first-generation Mandarin NS immigrants or second-generation Mandarin and English NS who grew up speaking both languages. For the purposes of this paper and ease of reference, I will just call the group "Mandarin NS."

when primed with front-back space-time metaphors. The L2 Mandarin group in my study shows much greater preference for the sagittal axis when primed with front-back metaphors when compared to the Mandarin NS group in Lai and Boroditsky (2013). This could signify a unique interaction effect in English NS cognition after advanced study of the second language. There is also a possibility that if I continued to test a greater number of individuals, my results might begin to look more like those of the Lai and Boroditsky (2013) experiment, showing greater variation in answers and preference, i.e., spreading out the preferences between the axes, displaying a larger tendency to choose the sagittal and vertical axes instead of the transverse axis.

Up-down Space-Time Metaphor Priming

My hypothesis for the up-down space-time metaphor priming was similar to the front-back priming in that I hypothesized that the L2 Mandarin group would show a relatively significant preference for the vertical axis. Results indicated that this was not the case. However, we do see the highest percentage preference for the vertical axis amongst the different priming test scenarios at 10% (compared to the 1.75% for front-back priming and 8.83% for non-spatial priming). As you can see in Figure 3 in Chapter 3, when primed with up-down spatial metaphors the L2 Mandarin

group significantly prefers the transverse axis (53.25%) to the vertical axis (10%), but there is no significant difference between the transverse axis and the sagittal axis (36.75%).

This finding could indicate one of two things: 1) that a significant number of participants in the L2 Mandarin group in my experiment might have a pre-existing affinity for the sagittal axis, regardless of priming effects or language used (there was at least one participant in the English NS group that displayed this, answering on the sagittal axis for every question), or 2) that there is some interesting interaction between the L2 Mandarin group's second language and their cognition. My first instinct in looking at the results of the data analysis, which produced significant results with large effect sizes, as well as observing the significant difference between the English NS group and the L2 Mandarin group is that the latter is the more likely. Since only one out of 15 English NS showed preference for the sagittal axis for each question, it is not likely that a large number of participants in the L2 Mandarin group also have this "preexisting affinity" for the sagittal axis, although further experimentation with a larger group size would be needed for greater certainty.

Non-spatial Language Priming

For English NS, my hypothesis for the non-spatial priming questions (and, really, all the test questions regardless

of space-time metaphor priming) was that they would significantly prefer the transverse axis. The results show this to be the case, confirming my hypothesis. Looking at Figure 4, you can see that the English NS group significantly preferred the transverse axis ($M = 5.6$) to both the vertical axis ($M = 0$) and the sagittal axis ($M = 0.4$), with p values of 0 in both cases and a partial eta squared value of .813, which indicate extreme significance and a massive effect size. In accordance with previous literature, English spatiotemporal metaphors are somewhat limited to the horizontal axis due to a plethora of linguistic and cultural factors, including writing direction, therefore it is no surprise that the English NS group displayed this preference for the transverse axis 93.3% of the time. Note that this is comparable to the results of Fuhrman, et al. (2011) that English speakers arranged time on the left-right axis 93.5% of the time.

For the L2 Mandarin group, which, if you recall from Chapter 2, is comprised of English NS who have been studying Mandarin Chinese for an average of 4.2 years and obtained an average ACTFL Listening Proficiency Assessment score of Advanced Low (Level 7 out of 10), my hypothesis was that when testing in Mandarin and not primed with space-time metaphors, i.e., when primed with non-spatial language questions, they would still display crosslinguistic influence in their mental representations of time, but would only show a slight

tendency to choose an axis other than the transverse axis on account of their exposure to and study of Mandarin Chinese. The results confirm my hypothesis. Again, looking at Figure 4, we still see a significant preference for the transverse axis ($M = 3.47$) to the vertical axis ($M = .53$), but there is no significant difference between the transverse axis and the sagittal axis ($M = 2.00$), which indicates that L2 Mandarin speakers were just as likely to prefer the sagittal axis as the transverse axis. I think it is also important not to overlook the slight preference shown for the vertical axis when compared to the English NS group. Although the preference did not significantly differ, it still reveals that L2 Mandarin speakers at least showed some preference for that axis, whereas the English NS group showed none. To sum up these results in percentages, the L2 Mandarin group preferred the transverse axis 57.83% of the time, the sagittal axis 33.33% of the time, and the vertical axis 8.83% of the time when primed with non-spatial language questions. This signifies that, *ceteris paribus*, learning Mandarin Chinese played a significant role in influencing the L2 Mandarin group's mental representation of time.

Referring to the Fuhrman, et al. (2011) experiment, the L2 Mandarin group in my experiment showed some similarities with the Mandarin speaking groups in their experiment. When prompted with non-spatial language, Mandarin speakers were equally likely

to arrange time on the left-right axis (46.8%) and the up-down axis (43.6%). My results indicate that L2 Mandarin speakers tested fell between English NS and Mandarin NS groups, which was expected. The difference, however, is that for some reason the L2 Mandarin group in my experiment had a much higher preference for the sagittal axis than the vertical axis. This could simply be due to differences in personal experience, or it could point to an interaction effect that Mandarin has on English NS cognition. This means that even without the immediate effect of spatiotemporal metaphors, Mandarin Chinese still influences the mental representations of time for L2 Mandarin speakers. This points to the possibility of long-term cognitive effects of language on conceptual perceptions.

V. Conclusion

This concluding chapter will first offer final comments and conclusions to the results of the study, followed by describing certain limitations that I encountered while designing and carrying out the experiment. The thesis concludes by discussing the contributions of this thesis and proposing suggestions for future studies in this field.

Conclusions

The results of my experiment indicate, in accordance with previous literature, that language does have the power to influence cognition, and in this

case, mental representations of time. From the results, this appears to be because of proximal, immediate effects of using the language due to the particular lexicon (in this study, the existence and usage of space-time metaphors) of the language, as well as due to long-term effects of using a second language on cognition as seen in the differences in responses between the English NS group and the L2 Mandarin group when primed with non-spatial language questions.

When primed with front-back spatiotemporal metaphors, L2 Mandarin speakers showed a significant preference for both the transverse and sagittal axes, with no preference distinction between the two. When primed with up-down spatiotemporal metaphors, L2 Mandarin speakers unexpectedly still showed significant preference for both the transverse and sagittal axes over the vertical axis, although noteworthy is that up-down metaphor priming resulted in the highest preference, albeit relatively small and statistically insignificant, in choosing the vertical axis compared to other types of priming questions. Lastly, the non-spatial language priming results suggest that there are long-term effects of learning Mandarin Chinese on English native speakers' concept of space-time; the results indicated that although the L2 Mandarin group significantly preferred the transverse axis over the vertical axis, they did not statistically differentiate between the

transverse and sagittal axes. Moreover, these results contrasted with the English NS group, which in this study acted as the control group, and statistically strictly preferred the transverse axis in all cases.

Limitations

This study has shed some light in understanding the effects of L2 learning on mental representations of time; there were, however, several limitations in conducting this study. First, I did not have access to a constant experiment space, so I sometimes had to conduct the experiment in relatively noisy spaces which could have distracted the participants when answering questions.

Second, recruiting advanced L2 Mandarin speakers was an issue due to the University of Mississippi Chinese Language Flagship Program's relatively small size; the number of students with advanced proficiency in the language are few. Thus, the pool of participants may not be as varied and the quantity simply might not be enough to obtain robust statistical results. The limited number of participants was also a barrier when designing the breadth of my study. Ideally, with a larger pool of participants I would have wanted to ask a portion of the L2 Mandarin group and a portion of the L1 English group front-back metaphor questions only, one portion of each group up-down metaphor questions only, and so on and so forth. This limitation was the

main reason for the "distractor questions" that I used.

Time was a limitation, as well. I originally planned on testing the L2 Mandarin speakers in both Mandarin Chinese and English to see if the same individuals preferred to answer using different axes depending on the language used when conducting the experiment. In order to do this, however, I would have needed a relatively lengthy gap between the first and second experiments with the same individuals so they could not draw any connections between the two tests and thus influence the way they answered. Unfortunately, there was simply not enough time to conduct this kind of experiment.

Last, because I was the only one conducting the experiment, I had to alter the way the three-dimensional pointing paradigm was used compared to previous studies⁴⁶ where someone other than the individual asking the questions would put their hand a foot in front of the participant as the reference point. I had the participants, themselves, put their fist out, which seemed to lead to some confusion with some of the participants. Moreover, where I sat in relation to the participant seemed to affect some of the participants' answers, as I was also the one asking them the questions.

⁴⁶ See Fuhrman, et al. (2011) and Lai and Boroditsky (2013).

Suggestions for Future Studies and Significance

For similar studies in the future, I would suggest that the three-dimensional pointing paradigm be altered or redesigned and the experiment slightly restructured. There were some instances in which participants pointed behind their own bodies in reference to concepts such as "yesterday" or "the past." Different results might occur if you were to make the participant's own body, e.g., their head or their center of gravity, the reference point off which they base their answers. This way, they would be forced to place themselves on the timeline, instead of looking at the timeline in front of them. With the current pointing paradigm, it automatically assumes that concepts such as "now" or "today" are in front of the participant, which may have influenced how the participant then chose to place the past and the future, amongst other concepts. Finding a larger pool of advanced L2 Mandarin learners and designing the experiment with more time allotted to experimentation and data collection would be ideal for more robust results, as well.

Nevertheless, this study contributes to the understanding of how language can shape thought. Further studies similar to this one will enable us to better understand not only differences in how distinct linguistic groups vary in thought and how their thought

processes might differ, e.g., how different peoples approach problem solving, or if different languages structure and restructure people's minds in ways that uniquely prepare them for certain types of thinking. Studying the effects of language learning on cognition also adds to the literature that signifies the importance and cognitive benefits of bilingualism and multilingualism. It would be most interesting to conduct a longitudinal study of the same participants over a period of time beginning from an advanced level and progressing to a distinguished (or even higher) level and then again observe the effects that the second language had on the participants' conceptual perceptions, not simply space-time, and cognition in general. The study of linguistic relativity in general, as well as studies of this nature which look at crosslinguistic influence on abstract concepts and perceptions of these concepts, is still in its infancy. The progress that has been made thus far, however, offers a promising outlook for future studies, and as technology and knowledge of the social sciences advance, it will be that much easier to observe and measure the effects of language learning on cognition.

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